PSYCHOLOGICAL LITERATURE

An Arraignment of the Theories of Mimicry and Warning Colors. By ABBOTT H. THAYER. Reprinted from the *Popular Science Monthly*, December, 1909. pp. 550-570.

Concealing Coloration in the Animal Kingdom: an Exposition of the Laws of Disguise Through Color and Pattern. Being a Summary of Abbott H. Thayer's Discoveries. By GERALD H. THAYER. With an Introductory Essay by A. H. Thayer. Illustrated by Abbott H. Thayer, Gerald H. Thayer, Richard S. Meryman and others, and with photographs. New York, The Macmillan Co., 1909, pp. xix, 260. Price $7.00 net.

Modern biology has occupied itself, in great detail, with the problems of organic coloration. The main field of discussion has naturally been that of the surface colors of animals; for internal and invisible coloration can have no biological significance, and "the dominant coloring of plants is an essential element in the paramount physiological activity of chlorophyll" (Poulton). In general it is held that the visible colors of animals, and in exceptional instances those of plants, have, for immense periods of time, been modified and arranged to assist in the struggle with other organisms or in courtship. There are, first of all, the phenomena of protective and aggressive resemblance, colors which enable an animal to conceal itself from its enemies or to approach its prey unseen, procryptic and anticryptic colors. There are warning colors and recognition marks, aposematic and episematic characters. There is the great mass of observed facts grouped under the head of mimicry: Batesian or pseudaposematic mimicry, an advantageous or deceptive resemblance borne by palatable or harmless species (the mimics) to others that are unpalatable or otherwise specially defended (the models); and Müllerian or synaposematic mimicry, the advantageous adoption of a common advertisement by specially defended species, whereby the loss of life incurred during the education of inexperienced enemies is contributed jointly by the similar forms instead of by every species independently. And, finally, there are the epigamic characters, explained by Darwin's theory of sexual selection. Color, at first incidental or non-significant, is thus supposed to have furnished admirable material for selection, natural and sexual, and to have played a large part in the mechanics of organic evolution.

With the central doctrine, that surface color is of high importance in the struggle for life, the author and inspirer of the two works under review has no quarrel. On the contrary, he very strongly insists on the adaptive character of coloration, of color itself and of color-pattern. He assumes the truth of natural selection; he believes, with Darwin, that natural selection operates upon small chance variations; he emphasizes the value to a species of adaptive preparation for such circumstances in its life as are of only occasional occurrence. But he insists, just as strongly, that expert judgment in the matter of the importance of coloration lies, not with the biologist, not even with the field-biologist, but with the student of color, the artist and the psychologist. Biologists have, with a few salient exceptions, appraised the conspicuousness or inconspicuousness of color and pattern from

the isolated specimen and, what is equally disastrous, from the human point of view. The right method is to set the animal in its natural surroundings, to bring its coloration and movement into relation with the colors and changes of its background; and then, having done this, to contemplate the animal from the point of view not of man but of those other animals which, whether as enemies or victims, have an interest in its discovery. If these rules are followed—and they surely need no defence—we have a surprisingly simple and uniform result: all creatures that ever prey or are preyed on prove to be colored in the manner best calculated to conceal them at the moments of their greatest need.

At first reading, this rule seems far too simple to be true; and as one reflects upon it, a large number of what seem to be obvious exceptions present themselves to the mind. Mr. Thayer has, therefore, done well to take the line followed in his book; to give his readers a great array of ocular demonstrations, clear of theoretical discussion. But he has also done well to preface the book by the article in the *Popular Science Monthly*, and to formulate his negations before he offers the positive testimony for his position. The article is intended to demonstrate the fallacy of the badge and warning color theories; and though it is not, in the same sense, an attack upon mimicry, it inevitably suggests that this theory cannot survive the demise of the others. Like the book, it has for its backbone a series of plates that demonstrate, beyond dispute, the primal effect of patterns and the wrongness of the older hypotheses about them. It begins by pointing out how "Darwin's erroneous supposition that a conspicuous mark on an object makes the object itself conspicuous has been built on and rebuilt on by the leaders of zoölogical research, even down to the present day. Entomologists, especially, make much of the supposed power of sharp and strong patterns to render conspicuous that particular part of the insect which they occupy." A fairly elementary consideration of the laws of irradiation, contrast, induction, as they operate under the conditions found in nature, is enough to prove that the effect of these patterns is the very opposite. Save for the comparatively rare moments when monotone exactly matches its background, pattern in aerial animals works for concealment in direct ratio to its own conspicuousness and elaboration.

The limits of space forbid my following the writer into his secondary arguments against warning colors and recognition marks; the fundamental arguments are, as I have said, furnished by the plates themselves. It must suffice to say that they are concerned in part with the intrinsic improbability or incoherence of the underlying theories, and in part with alternative explanations based upon the laws of visual perception mentioned above. The general argument against mimicry runs as follows: "As a few hours' experimenting in obliteration by juxtaposition of patterns will prove to any student, the optical laws which govern it are so absolute that one is not surprised to find that the whole world's butterflies have scarcely three different schemes of pattern. The principle of pattern arrangement in the famous 'mimetic' groups is out and away the predominant one over the whole globe. If this is the case, is it strange that in each most swarmingly populated seat of butterfly life there prove to be a number of species which, living in the very same station, and with seemingly identical habits, have, in obedience to this great pattern-law, practically identical patterns and form? We see in the ocean, for instance, even mammals wearing the shape and color of fishes." If this argument is sound—and Mr Thayer states that he has found no exceptions at all, after seven years of almost continuous investigation of the pat-

terns of the world's butterflies—Professor Poulton's occupation is gone. It is a little curious that Poulton himself, while he recognizes the principle of counter-shading and has even discovered its dynamic operation in the Chamæleon, apparently fails to see the danger which threatens his favorite studies. Yet Mr. Thayer's law, if it be established, makes the tracing of mimetic resemblances at best a mere side-issue, and at worst a futility.

It is to the establishment of the law that the book before us is devoted,—surely, for those who are interested in general biology, one of the most interesting books of all the recent crop. One naturally turns at first to the colored plates: to the Peacock amid foliage, the Ruffed Grouse in the forest, the Cottontail among ferns and moss and grasses. It is unnecessary to say that the creatures are admirably pictured, but it is pleasant to be able to add that the mechanical reproduction is satisfactory. These illustrations are convincing, as regards their special subjects; but their effectiveness is increased by another group of plates, in which the argument that they embody is generalized,—the plates showing drakes of the Wood Duck in the water, Blue Jays against snow, Birds of Paradise in the tropical forest, caterpillars of various species on leaves and twigs; and in particular, the plates which place a line of Spoonbills or Flamingoes against the dawn or sunset sky. These plates are nothing less than illuminating; and the Publishers' Announcement is keeping to the literal truth in its statement that "the colored plates anticipate the future of wild animal illustration, showing, for the first time, concealing colors *in operation.*" The picture of the Copperhead Snake caps the climax; the animal lies on a bed of dead leaves, and the plate is faced by a blank page from which its outline has been cut. Seen on the white ground, the animal is obvious, of course, by form and color; seen on the background of leaves, it disappears, and even a close scrutiny can trace its contour only with difficulty and by repeated reference to the blank form. All this must be seen to be believed.

There are sixteen colored plates, and there are a hundred and forty figures in black and white,—models, diagrams, photographs from nature. Here is the array of ocular demonstrations, upon which the thesis of the book mainly rests. That thesis is, to repeat, that "the entire matter [of animal coloration] has been in the hands of the wrong custodians. . . . It properly belongs to the realm of *pictorial art*, and can be interpreted only by painters. For it deals wholly in optical illusion, and this is the very gist of a painter's life. . . . This book demonstrates that the colors, patterns, and appendages of animals are the most perfect imaginable effacers under the very circumstances wherein such effacement would most serve the wearer, . . . the most gorgeous costumes being, in their own way, climaxes of obliterative coloration scarcely surpassed even by moths or inchworms. . . The means of objects' recognizability, no matter how they are colored or marked, is almost always their *silhouette—i. e.*, their outlines in 'relieving' darker or lighter or differently colored against their background. . . Patterns on animals' coats are the utmost that Nature can do in opposition to these potent vicissitudes of silhouetting." As regards terminology, Mr. Thayer recognizes Obliterative Coloration and Mimicry as the two main principles of Protective Coloration. The former principle covers all those concealing colors which serve to render the animals invisible in their native haunts. It is mainly based on counter-shading,—a discovery which was originally published in *The Auk* in 1896, has often been discussed and illustrated in recent years, and may therefore be assumed to be familiar to the reader. The second principle covers all those colors which

make an animal look like something else than what it really is; mimicry, that is, aims at deceptive visibility, while obliterative coloration aims at invisibility. It is, perhaps, regrettable that the writer uses mimicry in this wide sense, now that its use has been definitely restricted in current biological discussion; obliterative coloration might better be paired with, say, obliterative resemblance. However that may be, mimicry plays but a small part in the work; only a few examples are given, and these chiefly from among the lower orders; in the higher orders it has, in Mr. Thayer's opinion, a very secondary importance.

After the introductions—general by Mr. A. H. Thayer and special by Mr. G. H. Thayer—comes a series of seventeen chapters, dealing mainly with the markings of birds; three chapters are then devoted to mammals, one to fishes, one to reptiles and amphibians, and three to insects and spiders. It is difficult, where so much is given, to make a selection. But, if a choice is to be made, we may perhaps begin with the skunk, to which a good deal of attention is paid both in the *Popular Science Monthly* article and in the book. Belt, in *The Naturalist in Nicaragua*, tells us that at night "the skunk goes leisurely along, holding up his white tail as a danger-flag for none to come within range of his nauseous artillery." He describes the large white tail, laid over against the black and white body, as producing a very conspicuous effect in the dusk. There could not be, according to Mr. Thayer, a better instance of the naturalist's fallacy; the skunk's markings are beautifully obliterative. First, the mixed black and white of the body cause the animal to fade from sight at a short distance, and may even, at a near view, confuse themselves with details of forest and shrubbery. Secondly, a night is rarely so dark that a solid form within a foot of the eye would not show dark against the sky or against the light parts of the forest ceiling; hence, the white forehead markings, borne by the skunks and other grubbers of small surface life; the white markings counterfeit the sky, and are thus, as it were, seen through, as if transparent. Thirdly, the animal's white top has a cardinal function to perform; it effaces his upper contour against the sky to inhabitants of the turf; it too, therefore, is functionally transparent, an open space in the depths. And lastly, the skunk's tail is normally a mixture of black and white hairs, like a gray cloud. These points are clearly shown in Figs. 4 and 8-12 of the *P. S. M.* article, and in Figs. 95-103 of the book. The compound picture of Fig. 103 may, indeed, be said to furnish a key to the whole volume.

For a second instance, we may take the coloration of the Blue Jay, whose entire costume proves to be an arrangement of the brilliant colors of sunlit winter scenery,—his white the sunlit snow, his blues the varying shadows, his black the tree trunks and bare twigs, his ashy sides the haze of winter bushes. A glance at the plate facing p. 107 will train the reader's eye for observation of these facts in the open.

Lastly, a word may be said on nuptial colors. These, Mr. Thayer insists, are not to be ascribed to sexual selection, nor do they serve to render their wearers conspicuous. On the contrary, they represent plainly an increase of such potency of obliterative coloration as belongs to all gorgeously varied costumes, and this at the very moment when concealment is most needed. The puffin's bill, as he stands on guard at the mouth of the nest-burrow, serves by its gaudy color to obliterate the dark mouth of the hole, and at the same time substitutes a semblance of flowers to complete the deception. The moment his domestic duties are over, and he is back in the open sea, we behold

the bird dressed again in the universal ocean-and-rock colors of his habitat.——

Mr. Thayer's indictment of the naturalists may, if I have understood him aright, be summed up in four propositions. They have failed to realize that conspicuousness is solely a matter of relation to background; that black is conspicuous against white, and white against black, but that neither is conspicuous in and for itself. They have forgotten that there may be a vast difference between the conditions under which they see an animal and the conditions under which he is present, in nature, to his enemies or victims; so that his conspicuousness to human eyes may be altogether irrelevant. They have assumed, without test, that patterns make their wearers conspicuous. And, rightly noting the fact that aerial species in general are relatively conspicuous, they have failed to inquire whether any change of costume would remove or lessen this source of danger. In support of his own view—less, perhaps, a view than a discovery—Mr. Thayer offers a multitude of actual observations, covering all the main divisions of the animal kingdom. The labor involved in these observations has been immense, but has evidently been a labor of love. As such, it is its own reward; though external reward will also come in the conversion of many readers to the painter's, or, as I should prefer to say,—if this change of terms may be made without injustice,— to the psychological standpoint. No doubt, there remains the great and ultimate question of causation; but that remains for the followers of Bates and Müller no less than for Mr. Thayer.

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Handbuch der Schwachsinnigenfürsorge mit Berücksichtigung des Hilfsschulwesens, Herausgegeben von Hans Bösbauer, Leopold Miklasu. Hans Schiner. Wien, Karl Graeser & Kie, 1909.

The following are the chapter headings: I. The nature ef Feeble-mindedness. II. The kinds of Feeble-mindedness. III. Symptoms of feeble-mindedness (a) Bodily (b) Psychic. IV. Causes. V. Measures for prevention. VI. History of the movement for care of the feeble-minded. VII. Education and treatment of the feeble-minded. VIII. Forms of education. IX. Organization of institutions and "Special classes" (Hilfsschulen). X. Instruction. XI. Personality of the teachers. XII. After-care for the children who go out from the institutions and classes. XIII. Legal protection for, and military service by, the feeble-minded. XIV. Bibliography.

As is evident from the contents, the subject is discussed in many phases. The writers have gone over the literature with great thoroughness and have brought together many important facts and opinions. The book is conservatively written and gives no new data nor takes any advanced stand on any of the important questions involved. Most of the opinions quoted are given without criticism. The usual "causes" are given and discussed without much consideration of their relative importance. *E. g.*, alcohol is taken as a serious matter and important cause. No hint is given that any one doubts that it is an important cause.

In discussing "prevention," most everything is spoken of except the regulation of marriage—which would probably stop 80% of the trouble. Mention is made in fine print of a "*strange kind*" of law that has been passed in Indiana (the law authorizing castration). That is the only reference to that important matter. In discussing symptoms and education and treatment, the authors labor under the difficulty of too few heads of classification. "Feeble-mindedness" covers a wide range of conditions. It is not possible to discuss the